1/9/24.

CENTRAL NERVOUS SYSTEM.

Nervous system

- Central nervous system (CNS)
  - Spinal cord
  - Brain
- Peripheral nervous system (PNS)
  - Cranial nerve
  - Spinal nerve
  - ANS
    - Sympathetic
    - Parasympathetic

BRAIN

- Forebrain (prosencephalon)
  - (1) Telencephalon (C.H.S & ventricles)
  - (2) Diencephalon.
    - Thalamus
    - Hypothalamus
    - Metathalamus
    - Subthalamus.
- Midbrain (mesencephalon)
  - (1) Cms cerebri
  - (2) substantia nigra
  - (3) Tegmentum
  - (4) Tectum
- Hindbrain (rhombencephalon)
  - (1) Metencephalon. pons & cerebellum
  - (2) myelencephalon medulla oblongata

NEURON.

- Structural & functional unit of N.S.
- There are 10 neurons in N.S.

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Classification.

(a) Depending on the action.

(i) Sensory neurons: Receive impulse from receptors

(ii) Motor neurons: send impulse to muscles & glands

(b) Based on length of axons.

(i) Golgi type 1 (long axon)

(ii) Golgi type 2 (short axon)

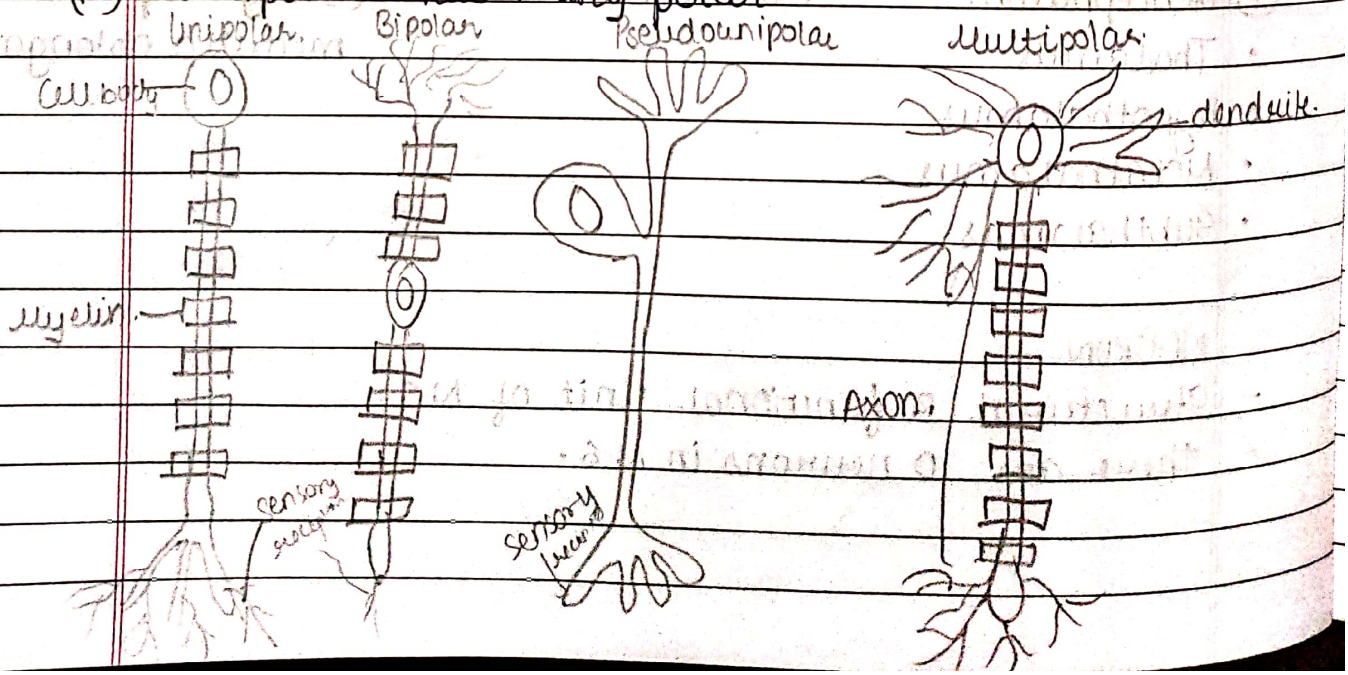
(c) Based on no. of poles.

(i) unipolar - has one ~~pole~~ pole from which both axon & dendrite take origin.

(ii) ~~pseudopolar~~ unipolar - This neuron contains an axon that has split into two branches: one branch runs to the periphery and the other to the spinal cord.

(iii) Bipolar: has 2 poles, from the one pole dendrite take origin & from the other pole axon take origin.

(iv) Multipolar - has many polar.



Structure of multipolar neuron.

1. Soma (nerve cell body)

It contain following structures.

nucleus.

- present in center of soma
- 1-2 nuclei are present.
- no centriole, hence don't undergo cell division.

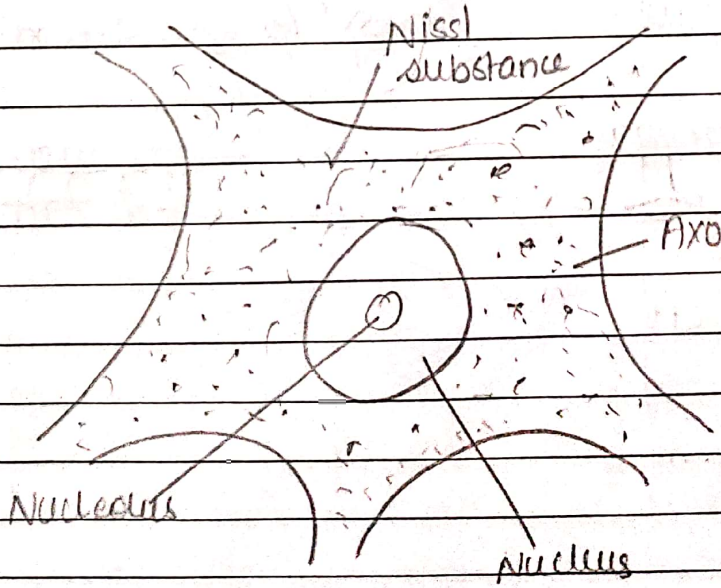
Mitochondria, golgi body, E.R, vacuoles, neurofibrils.

NISSL BODY.

- They are granules which are found in the soma & dendrites but they are absent in axon hillock (part of soma where the axon take origin)
- They give spotted appearance to soma (Nigond bodies)

Functions.

Contain ribosomes which help in protein synthesis since axon doesn't contain nissl body, the protein produced in soma is transferred to axon by a process caued Chromatolysis.



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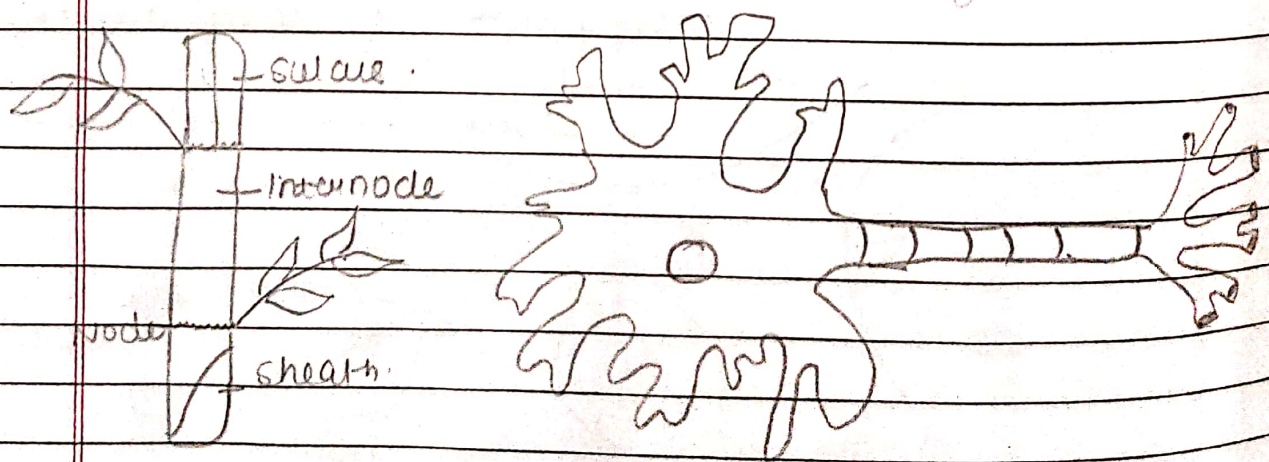
Coverings of axon

1. Myelin sheath.

- It is covering of axon present in myelinated nerve fiber.
- chemically it is made up of lecithin & sphingomyelin.
- process of synthesis of myelin is called as myelingeses (begins in the 4th month of IU life and gets completed 1& half - 2 yrs after birth.
- Myelin is synthesized by oligodendrocytes in the CNS & by schwann cells in the PNS.

Distribution of myelin sheath.

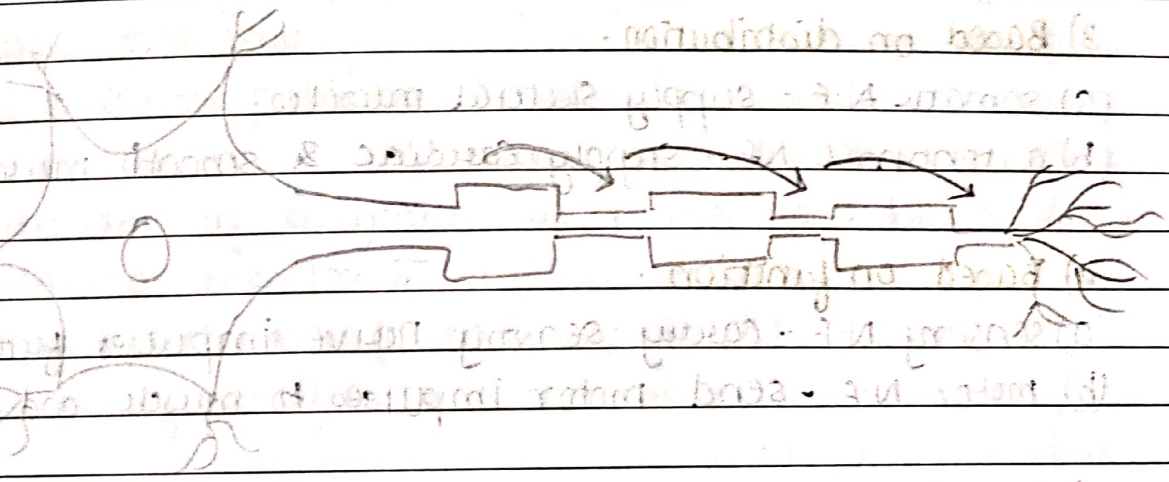
- It is not continuous. It is absent at regular intervals.
- The area where myelin sheath is absent is "node of ranvier"
- The part of axon b/w 2 adjacent nodes of ranvier is.
- presence of nodes & internode gives bamboo stick like appearance to axons.



Function of myelin sheath:

- It acts as an insulator (doesn't allow conduction of nerve impulse / action potential). Hence nerve impulses jump from one node to another this type of conduction is called as "saltatory conduction". Therefore conduction is faster in myelinated N.F compared to non-myelinated N.F.

Action potential appears to jump from node to node.



2. Neurilemma

- It is the outer covering of axon which is present in both myelinated & non myelinated N.F.
- Neurilemma is present in axons of PNS & absent in CNS
- Between neurilemma & myelin sheath there are schwann cells.
- There is only one schwann cells for each internode.
- They synthesize mylein in PNS.

Classification of nerve fiber

1) Based on histology.
(a) myelinated
(b) non myelinated.

2) Based on origin.
(a) Cranial N.F - take origin from brain.
(b) Spinal N.F - arise from spinal cord.

3) Based on distribution.
(a) somatic N.F - supply skeletal muscles.
(b) autonomic NF - supply cardiac & smooth muscles.

4) Based on function.
(a) sensory N.F - carry sensory nerve impulses from PNS to CNS
(b) motor N.F - send motor impulses to muscle and glands.

5) Based on diameter (Gasser Erlangers classification)

Fiber type	Diameter	Conduction velocity (m/s)	Function
A.			
α	12-20	70-120	proprioception somatic fiber
B	5-12	30-70	touch, pressure
A gamma.	3-6.	15-30	Muscle spindle.
A delta	2-5	12-30	Touch cold (temperature) Fast pain
B	< 3	3-15	Autonomic
C.	0.3-1.3	0.7-2.3	autonomic, slow pain

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Response of N.F. to a stimulus -

- nerve response is based on the electrical charges or ions present in ICF & ECF.
- These ions enter or exit through the membranes of NF
- This membrane is selectively permeable and contains gates for ions like Na, K which open or close based on the voltage differences across the membrane.
- Neurons are electrically excitable, they communicate with another using 2 types of signals
  1. graded potential
  2. nerve action potential / nerve impulse.

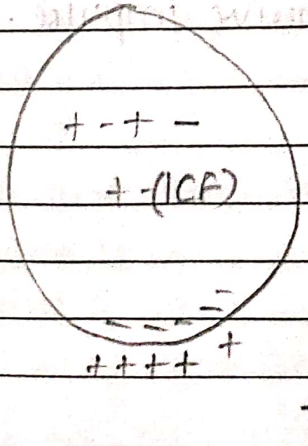
- Production of response is based on 2 basic features of plasma membrane of nerve cells.

a) Resting membrane potential (R.M.P)
b) Presence of specific ion channels.

a. Resting membrane potential (R.M.P)

- plasma membrane of excitable cells exhibit a membrane potential i.e; an electrical voltage difference across the membrane. It is called as R.M.P.
- In neurons RMP ranges from -40mv to -90mv & its typical value is -70mv.

In the resting state N.F. is in polarized state.



b. Ion channels or gates.

i Leakage gated channels: for K+ & Na+ ions (selective permeability)

ii Voltage gated channels: they work on principles of change in the voltage gradient across the membrane. (mainly present in axon terminals).

iii Ligand gated channels.- for hormones, neurotransmitters which directly / indirectly close / open these channels

iv Mechanically gated channels - open / close in response to mechanical stimulus (vibration, pressure, stretch, etc)

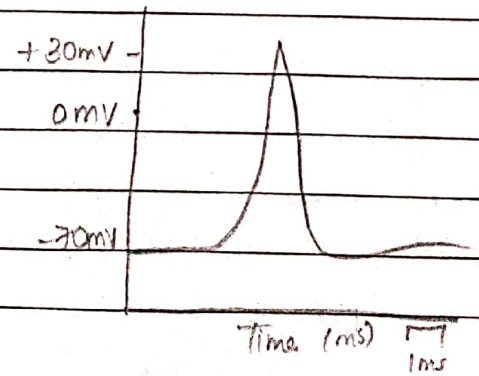
eg: auditory receptors, stretch receptors.

1. Graded potential

- It is local potential produced in the N.F after a sub minimal stimulus
- It is non propagative.
- It doesn't obey "all or none law"

2. Nerve action potential / nerve impulse

changes which take place in the RMP of nerve fiber during polarization, depolarization & repolarization is called as action potential or nerve impulse.



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* Properties of nerve fibers.
(1) Excitability
(2) Conductivity
(3) All or none law
(4) Refractory period
(5) Summation
(6) Adaptation
(7) Infatigability.

1. Excitability
it is defined as a physiological change that occur in a tissue when a stimulus is given.
"It is the response of N.F. to the stimulus

(stimulus is the external agent which produces excitability in the tissue.
Depending on strength, stimulus may be sub-minimal/ minimal/ submaximal/ maximal / supra maximal)

the nerve can be stimulated by a suitable stimulus which may be.
- mechanical
- thermal
- chemical
- electrical.
After excitation, nerve impulse is generated through depolarisation, repolarisation & hyperpolarisation.

Excitability depends upon the following factors.
(a) strength of stimulus
(b) Duration of stimulus
(c) Direction of the current.

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(d) Frequency of stimulus.
(e) Injury

2. Conductivity
"ability of N.F. to conduct a nerve impulse or action potential"
Factors which influence conductivity.
(a) Diameter of N.F. - "Larger the ~~small~~ diameter of N.F. fiber faster the conductivity" (Aα is the thickest hence has fastest conductivity & C nerve fiber is thinnest hence slowest)

(b) Myelination.

(c) Hypoxia - ↓ conductivity

(d) Acidosis - ↓ conductivity

(e) Ischemia - ↓ conductivity.

(f) Local anesthetic drugs - reversibly block conduction & produce loss of sensation.

3. All or none law.
- It states that an action potential will develop in the N.F. only if stimulus strength is equal to or greater than the threshold strength (-55mV)
- If stimulus strength is weaker than threshold strength, action potential will not occur in N.F. (In this case a local potential will develop called as graded potential)
- When stimulus strength is ≥ threshold strength all

sodium channels will open otherwise none of them will open.

4. Refractory period.
- It is a period during which a N.F does not respond to a stimulus or can not generate an action potential (because it coincides with Na^+ channel activation and inactivation).
- A N.F. can respond to next stimulus only after Na^+ channels come to resting state after inactivation.

R.P → (a) absolute R.P.
(b) Relative R.P.

(a) absolute R.P. (A.R.P) -
It is the period during which a N.F. doesn't show any response to a stimulus whatever may be the strength of stimus.

(b) Relative R.P.
A time in which the neuron can fire an action potential, but it needs a greater stimulus.

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5. Summation.
When one sub minimal stimulus is applied, it doesn't produce any response to the N.F. however if many sub minimal stimuluses are given repeatedly to the N.F or given at points very close to one another, the sub minimal stimuli will add / sum up to produce an action potential in N.F.

6. Adaptation.
When a N.F is continuously stimulated, initially it will show a response, later it will not show any response. This is due to inactivation of Na^+ / K^+ pumps because of continuous stimulation.

7. In / defatigability
a N.F will not undergo fatigue even if it is stimulated continuously because it can conduct only one action potential at a time.

* Receptors.
Receptors are the specialized structures which respond to internal or external stimulus".
Classification -
1. Extero receptors → cutaneous receptors
chemoreceptors
telereceptors.

2. Intero receptors → viscero receptors
proprioceptors.

Extero receptors → receptors which show response to external stimulus.

- cutaneous receptors (mechanical receptors):
present in skin, sensitive to touch, pain, pressure & temperature.

Sensation	Receptors
Touch	Tactile receptors • meissner's corpuscle (light touch) • merkel's disk.
Pain	Nociceptors (free nerve endings)
Pressure	Pacinian corpuscles (deep touch)
Temperature • cold • warm	Thermo receptors. • krause's end organ • ruffin's end organ.

- chemoreceptors:
sensitive to an external chemical stimulus
Ex. receptors for smell - olfactory neurons
receptors for taste - taste buds.

- telereceptors: (distance receptors)
They are sensitive to the stimulus which is coming from distance / away from the body.
Ex. receptors for sound - organ of corti (hair cells)
receptor for vision - rods and cones of retina.

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Intero receptors → they are sensitive to internal stimulus

• Viscera receptors

present in viscera like heart, lungs, blood vessels, GIT, urinary tract, brain

Viscera receptors	sensation.
Baro receptors.	Blood vessels
Central chemoreceptors	ventral surface of the brainstem's medulla.
stretch receptors.	heart, lungs, ~~&~~ stomach, etc.
Osmo receptors.	Urinary tract, brain (BBB)

• Proprioceptors.

proprioception = "one's own" (L)

sensory receptors which receive stimuli within the body, especially one that responds to position & movement'

Presen in muscles, tendons, joints & inner ear.

They are sensitive to muscle length, muscle tension & equilibrium (position) of the body.

Proprioceptors	Name	Function.
Receptors of muscle tone	1. Muscle spindle 2. Golgi tendon organs.	1. Sensitive to change in muscle length 2. sensitive to change in muscle tension

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Receptors of equilibrium	Hair cells, macula of utricle & saccule.	Body positioning

* Properties of reception.
1. Law of specifity (Muller's law)
2. Weber Fechner's law.
3. Transduction.
4. Generator potentional (receptor potential)
5. Recruitment
6. Adaptation.

1. Law of specificity (Muller's law)
- Muller's law states that the receptor will show response to a specific stimulus.

Ex. pain receptors show response to only to painful stimulus & not to touch stimulus.

2. Weber Fechner's Law
- It states that response of a receptor is directly ∝ to logarithm of strength of stimulus.
- If the response of the receptor has to be doubled then the strength of the stimulus has to be increased 100 times.

3. Transduction.
- Transduction = conversion of one form of energy into another.
- Receptors act as biological transducers.
- Ex. touch receptor converts mechanical energy into electrical energy (action potential)
- Taste bud converts chemical energy into electrical

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energy (action potential)

4. Generator potential (receptor potential)
- When a receptor is stimulated, it will undergo depolarization & become more permeable to Na^+, this will cause production of local potential in receptor called generator potential.
- When the Generator potential > threshold strength, it is converted into action potential.

5. Recruitment
- When the strength of the stimulus is increased, more no. of receptors are stimulated.
This is called as recruitment.

6. Adaptation
- When a receptor is continuously stimulated, it will initially show a response, later it will not show any response
- The receptors which undergo rapid Adaptation are called as phasic receptors.

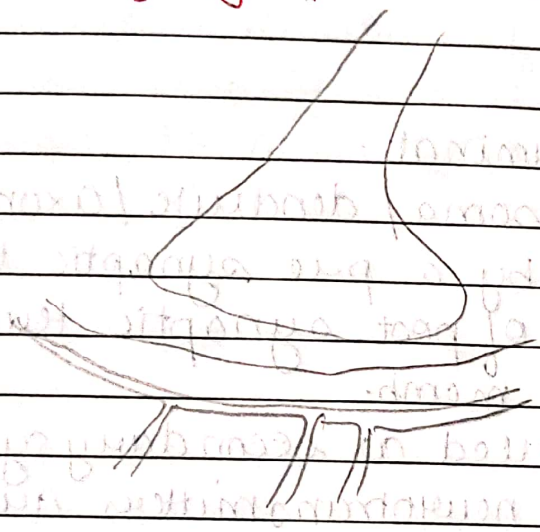
Ex. receptors of touch, temperature, pressure.
- Receptors which undergo slow adaptation are called as tonic receptors.

Ex. pain receptors, muscle spindles, cold & receptors.

SYNAPSE:

A junction betⁿ 2 neurons is called as synapse. It helps in transmission of impulse from one neuron to another.

Structure of synapse.



Synapse is made up of following parts.

1) Pre synaptic terminal

- It is formed by terminal part of axon.
- It is globular in shape & it invaginates post synaptic terminal.
- Membrane of pre-synaptic terminal is called as pre-synaptic membrane.
- Pre-synaptic terminal contains numerous synaptic vesicles which contain chemical substance

2. Primary synaptic cleft / synaptic gutter
- It is the gap betn pre and post synaptic terminals.
- It contains ECF.
- Neurotransmitters have to cross the primary synaptic cleft to reach the receptors present on secondary synaptic cleft.

3 Post synaptic terminal
- It is formed by soma / dendrite / axon.
- It is invaginated by a pre synaptic terminal.
- Cell membrane of post synaptic terminal is called as post synaptic memb.
- It shows folds called as secondary synaptic cleft.
- The receptors for neurotransmitters are present on the secondary synaptic cleft.

Classification of synapse.

1. Anatomical classification.

a. Axo-somatic synapse → junction bet^{n} axon of one neuron and soma of another neuron (commonest synapse in CNS)

b. Axo-dendritic synapse → synapse bet^{n} axon of one neuron & dendrite of another neuron.

c. Axo-axonic synapse → synapse bet^{n} axon of one neuron to axon of another neuron.

2. Functional / physiological classification.

a. Chemical synapse

synapse in which presynaptic terminal is separated by a synaptic cleft. Transmission of impulse across the synapse is done by neurotransmitter.

b. Electrical synapse.

- In this synapse the cell memb. of pre synaptic & post synaptic terminals are connected by a "gap junction"

- Ions are exchanged betn pre synaptic & post synap terminal through gap junction.

Functions of synapse (synaptic transmissions)

2 types of synaptic transmission.

1. Excitatory synaptic transmission
2. Inhibitory synaptic transmission.

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